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Programmed learning appears to offer great promise as a means of individualizing instruction. Programmed learning materials, if well constructed, provide a "built-in" motivation. They offer opportunities for in-service education of teachers and appear to hold great promise as a means of providing "breathing space" in school programs for both teachers and learners. Resistance to introducing new subject matter into the curriculum can be broken down by programmed learning. In order to implement a course of programmed learning, the professional staff must be informed, contacts should be made with other systems which have made a start in such a program, advice and assistance should be obtained from the Center for Programmed Instruction, and teachers should be sent to the training center for special sessions.

It is increasingly evident that the major responsibility for the future of programmed learning rests primarily with public school educators, who must take the imitiative.

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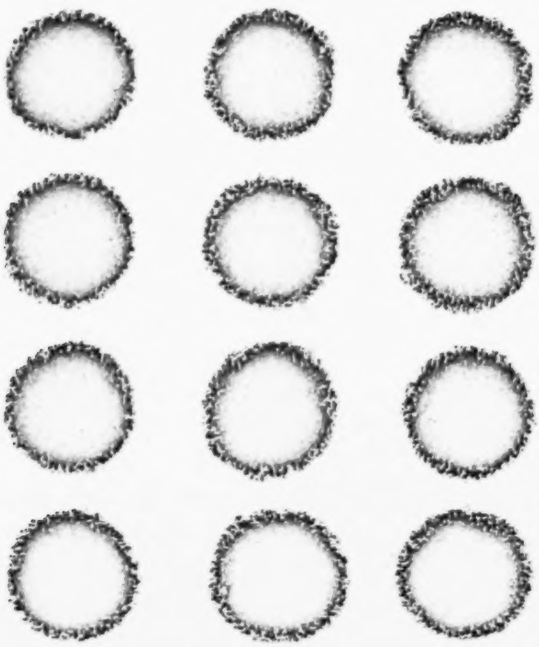
Programmed Learning in Public Schools

This is my thirtieth year of service in public education and I cannot in my memory, recall a time of greater ferment, of greater pressures, or of greater challenge. We are faced with demands for dramatic changes and reorganization of both content and methodology in subject fields such as science and mathematics. This total



body of knowledge – the sum total of all there is to know – reportedly has doubled in the past twenty years and continues to increase by a kind of geometric progression. Technological developments applicable to education have outdistanced professional planning for using them intelligently. New developments in learning theory challenge the validity of many existing methods of teaching. Societal pressures and concerns have reached an all time high. Parents increasingly view education as the magic touchstone to success. The college degree has become a more important status symbol than the Cadillac. On the national scene, education has become at the same time the "whipping boy" for past failures and the one best hope for the future. The "Pursuit of Excellence" in education, at least, has become a national byword. Major foundations are granting millions annually to encourage "breakthroughs" in teaching methods, in teacher education, and in school organization.

I can recall a time in the very recent past when one took a calculated risk to talk to groups of parents about educational "experimentation". Experimentation was

suspect. Now it is highly respectable and if anything, it is the "status quo" which is suspect. Superintendents of schools, always sensitive to changes in public attitude, are tempted to climb on the nearest or most recent bandwagon. Both professional and popular journals are filled with glowing accounts of Newton Plans, Joplin Plans, Lexington Plans, Norwalk Plans, Dual Progress Plans, Accordion Plans, and "Three Rail" Plans. What appeared to represent the ultimate in the use of educational television was the Hagerstown Experiment. But now we have Midwest Airborne and a

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new development called Phonoscope, still in its embryo stage down in Galveston, Texas. It is not my purpose to disparage these efforts. Most of them represent an honest search for better methods of teaching and learning. They do, however, serve to illustrate the educational climate in which we find ourselves in the 1960's and the almost frantic efforts to adjust education to the demands of the times.

It is against this background of pressures and ferment in education that I should like to talk about "programmed learning". As one whose major responsibility is the improvement of instruction in a particular school system, there are several reasons why I am especially interested in this new development:

1. It appears to offer great promise as a means of individualizing instruction. Learning has always been an individual process, but this has not been true of instruction. The best that most teachers can do is to attempt to group children according to ability for instruction—but differences within ability groups remain as great as differences between groups.

J. BERNARD EVERETT *Dr. Everett is Assistant Superintendent for Instruction in the Public Schools of Newton, Massachusetts. He received his B.A. Degree from Edinboro State Teachers College, his M.A. Degree from the University of Pittsburgh, and his Ed. D. from the Teachers College, Columbia University. He is co-author of two books and has written many articles.*

Although millions of foundation dollars have been spent thus far in attempts to find better answers, most of these efforts have been directed to the problem of teacher utilization, to the use of mass media of communication and to techniques of large group instruction. For example, a major shortcoming of instruction via television, whether it be open channel, closed circuit or airborne, is that it is relatively inflexible and cannot easily be adjusted to individual differences on the part of learners. Theoretically at least, programmed materials provide each learner with the opportunity to learn and advance at his own rate. In classes which I visited in the Roanoke Schools (and I shall have more to say about this later) some children had covered three times as much material and apparently learned three times as much as other children who were working in the same class. Some would finish a course normally covered in a year before the end of the first semester. And with no homework. Because of the conditions of the experiment, all work was done during regular class periods.

2. Programmed learning materials, if they are well constructed, provide a kind of "built-in" motivation. The immediate reinforcement of knowing that one has answered a question or solved a problem correctly before moving on to the next, seems to provide a sense of purpose and enthusiasm for learning. This is not due simply to the fact that answers are provided. It is probably due more to the fact that new learning is broken into such small sequentially organized steps that even slow learners are able to enjoy success. It is a new experience for many children to

know that they are learning and making progress.

3. Programmed learning would seem to offer unique opportunities for the in-service education of teachers. I do not mean by this that all teachers should become programmers. Rather, I believe that it would be a valuable experience for all teachers to learn how to program and to have a brief experience, at least, in trying to program some aspect of learning. My assumption is that teachers would gain many new insights about the complexity of the learning process and the sequential steps by which children learn new information or skills. All too frequently teachers fail to provide the necessary foundation for new learning, assignments are not clearly explained, and the availability of necessary information is not carefully considered. In discussion, too much emphasis is placed on spotting the child who doesn't know the answers. Fear of failure rather than the satisfaction of success becomes the chief means of motivation. Education comes to be regarded by many as a battle of wits between the teacher and the learner.

   Teachers who have tried to write programs report that they have found it to be a "humbling" yet enlightening experience. Most of them have said that they would never again take as much about learning for granted —in fact, that they would never teach quite the same again. And because of these new insights I assume that they would become better teachers.

4. Programmed learning appears to hold great promise as a means of providing "breathing space" in school programs both for teachers and learners. If children can indeed become more independent of the teacher — this, in turn, frees the teacher to explore aspects of teaching which were difficult, if not impossible, to explore before. There will be much greater opportunity to work with individuals and with groups which are more nearly homogeneous in relation to a particular aspect of learning. There should be more time for discussion, for writing, for analysis, and hopefully for thinking and planning. It should permit the teacher to be a teacher instead of mere "drill master" or "information fixer".

   It is possible that programmed materials could relieve some of the pressures on our elementary schools. The vast majority of elementary schools are still organized on a self-contained classroom basis. Experienced teachers try very hard to provide for the entire range of abilities within their classrooms, but it is frequently a losing battle. Most inexperienced teachers, and there are thousands of them, are even less capable of dealing with the problem. In classrooms in which a serious attempt is made to organize instruction on a group basis, a good part of the child's day is spent on individual learning activities. Whenever a teacher is meeting with a particular group, the rest of the children are working on their own. All too frequently such individual study is hastily planned, poorly motivated and often not understood. When a child meets blocks to learning the teacher generally is not immediately available to help him.

   Add to the problem of providing for individual differences, the need to introduce new subject content and teaching methods, as in the case in mathematics, science, and languages, and the total problem becomes well nigh insurmountable. Teachers are

literally pulled in many different directions at the same time, yet appear to make only a small dent on the problem. A few schools are experimenting with team teaching. Many more are returning to some sort of ability grouping or departmentalization. Both of these methods have been tried in the past with results which were something less than spectacular. However, the vast majority of schools still retain the self-contained classroom type of organization and struggle frantically to cope with the twin problem of individual difference and new subject content.

It would appear that in this setting, if I have portrayed it accurately, programmed materials could be extremely helpful. If some aspects of learning can be programmed successfully, we may be able to stop our frantic scramble for new methods of grouping and organization and salvage some of the advantages of both the self-contained classroom and team teaching.

If children can learn certain skills and information faster and more efficiently, then hopefully more of their time can be devoted to creative and esthetic experiences all too frequently neglected at the present time. The typical high school student may be able to meet the ever increasing academic demands and still find time to play in the symphony orchestra and work in the art studio.

5. Programmed learning offers considerable promise as a means of breaking a serious "bottleneck" in introducing new subject matter into the curriculum. Let me refer, for example, to the current revolution in mathematics. The bottleneck in this instance is the re-education of teachers. Under present conditions, the new mathematics cannot possibly be introduced into the curriculum of a particular school until the teachers understand the changes in content and methodology which are involved. Most of the new systems of mathematics such as the U.I.C.S.M. and S.M.S.G. recognize the necessity of teacher education and will not make their materials available to schools unless the teachers involved undergo a period of orientation and training. What with the ever present problem of teacher turnover, this makes the introduction of modern mathematics tortuously slow in the secondary schools and almost impossible in the elementary schools where many teachers may not as yet thoroughly understand the old arithmetic. If much of modern mathematics can be programmed, and there already is evidence that it can be, then one of the major bottlenecks may be broken. Teachers and pupils can become learners together with the teachers hopefully, of course, a considerable number of jumps or "frames" ahead of the pupils.

Now, in citing all of the foregoing reasons why I am optimistic about the promise of programmed learning, I should like to make it clear that it is still only a promise. Whether the promise is eventually realized or not may depend upon what happens in the next two or three years. For example:

1. Will adequate time and funds be made available for further research and experimentation with programming techniques before they become crystallized through "the mass production of programs". The educational materials field is a highly competitive one. Already there are

indications that companies which have never before ventured into the textbook field are hoping to capture a significant portion of the market before the regular textbook publishers are aware of what is happening. The rush to be first on the market with a new product and to make a substantial profit on it may discourage the kind of painstaking research and investigation which is needed at this time. Publishers and producers of programmed materials will be tempted to initiate the mass production of materials on the basis of what we now know about programming, and without sufficient attention to the testing and revision of the materials themselves.

2. Will careful and thoughtful consideration be given to the kind of learning which should be programmed? For example, will the time ever come when we will develop a logical and effective synthesis of all available learning materials and techniques. Too often each new development is viewed by its proponents as a "panacea", and the answer to all of our educational problems. This certainly has been true in the case of educational television. Will the same error be made in promoting programmed learning?

   Now I do not profess to know what kinds of learning can be most effective through the use of programmed materials. But I am sure that some kinds of learning require the interplay of minds — the interaction of teachers and learners. Other kinds depend upon direct experience in a science laboratory, an art studio or a musical ensemble. I would assume that there will always be an important place for textbooks, reference books, and libraries. I also hasten to add that I believe that films, tapes, and television can make a unique contribution — and I would re-emphasize the word "unique". What appears to be needed, therefore, is a continuing search for the particular combination or synthesis which will be most effective for each individual learner.

3. Will leaders in the teaching profession direct their attention to a thorough and intelligent exploration of the potentialities of programmed learning? Or will they, as they have so often done in the past, either go on the defensive or bury their heads in the shifting educational sands? All of which raises another interesting question, "Who are the conservatives in education today?" In a period of pressures and ferment it is difficult to tell. Are they the innovators or those who "view with alarm"? It seems to me that anyone who is completely doctrinaire about a particular philosophy or learning theory is a conservative whether his brand be progressive, or child development or basic education. The leadership which we need at the present time must come from those who have maintained a dispassionate, scientific attitude toward learning, who recognize changing conditions and who are willing to test new ideas and learning theories whether they square with their own or not.

What probably is the largest commercial venture in the development of programmed materials is currently centered in Roanoke, Virginia. Encyclopedia Britannica Films is reported to have invested a half million dollars in what apparently is an effort to steal a march on the textbook publishers. The programs are being developed at Hollins College on the outskirts of Roanoke, under the direction

of Dr. Allen Calvin, head of the Department of Psychology at the college. To illustrate the speed at which they are moving, last summer a team of eight mathematicians completely programmed all of high school mathematics and the first year of college mathematics. Currently, a team of language specialists is developing programs in Spanish, German, and French.

The mathematics materials, which are cast in the form of programmed textbooks, are being tested this year in the public schools of Roanoke and in four school systems in other parts of the country. Late in November, I spent a day in the Roanoke Schools visiting classes in which the programmed materials were being used. Each teacher involved in the experiment has two classes which are using programmed texts. In one of the classes she is allowed to give the pupils some help. In the other, they receive no help. There are no homework assignments. All work must be done during the regular class period. Each teacher also has a third class in the same subject which she teaches with conventional methods and materials.

I came away with many reservations about the project as a whole. The subject content, for example, had been determined by an item analysis of existing state courses of study, rather than by a consideration of new trends in the teaching of mathematics. Hence, it represents the dead level of what is now being taught rather than what should be taught. Most of the programmers had been graduate students rather than recognized mathematicians. Considering the volume of materials which they had produced, they must have worked at a breakneck pace which allowed little time for the testing, revision and retesting of individual frames. However, in spite of all these reservations, I could not help being favorably impressed by the reaction of the students and by their apparent progress in learning. As I indicated before, in every class there were some students who had covered nearly three times as much ground as others. Many would finish what is normally a full year's course by the end of the first semester.

In general, the fastest traveling students indicated the greatest enthusiasm; the slowest, especially in classes where no assistance from the teacher was allowed, displayed some frustration and discouragement. This may, of course, have been due to gaps and imperfections in the programs which could be bridged by the abler students but which blocked the less able. Nevertheless, on the whole, motivation seemed to be high in all the classes which I visited. The vast majority of students appeared to be working with greater purpose and interest than one would be likely to find in classes using conventional methods and materials.

Finally, I would like to report briefly on what we are doing about programmed learning in the school system which I represent. It is only fair to admit that we are one of those favored suburban communities which enjoys reasonably adequate financial support, an enlightened public, and freedom from political domination. We have a long history of educational experimentation which has conditioned both the professional staff and the public to expect us to keep abreast of new educational developments.

Although, as yet, we are not deeply involved in programmed learning, we have taken these steps:

1. We have been trying to inform our professional staff. This has involved bringing speakers like Mr. Komoski to numerous staff meetings, visiting experimental centers, such as Professor Skinner's laboratory at Harvard, and making available professional literature on the subject of programming. We have been trying to establish the idea that programmed learn-

ing is more truly an outgrowth of psychological research than a product of the machine age. It seems to us imperative that an understanding and acceptance of the learning theories, implicit in programmed learning, be developed among members of a teaching staff before it is introduced in the schools.

2. We have established a committee on programmed learning representing all instructional levels. It is considering how rapidly we should move, in what subject areas, and at what grade levels. The committee also will consider the probable effects of programmed learning in the total teaching process – how it will affect school organization, the daily schedule, and the role of the teacher.
3. We have made an initial effort in the development of programmed materials. Last spring we sent one of our teachers to the Center for Programmed Instruction in New York to learn what he could about programming. He was a member of a team which had been developing materials in modern mathematics for teachers and pupils in the elementary schools. During the summer, he developed a brief programmed text of approximately 300 frames on Prime Numbers and Factors. He was able to do some testing of his materials on students in the Harvard-Newton Summer School. However, as we use the text with classroom groups this year, we expect to find the need for considerable further revision.
4. We have established contacts with other school systems which have made a start at developing programmed materials. In this way, we hope to assist each other in the development and testing phase and eventually to share the materials. We have, for example, sent to the Denver Public Schools enough copies of our programmed unit in mathematics for them to use with two or three classes. They will make a frequency check of the error rate and report this to us together with their analysis of the program itself. Denver, in the meantime, is developing programmed materials in high school English, specifically, I believe, in punctuation, grammar and correct usage. As soon as these are available, we hope to use them in at least one of our high school English classes. Later on this month, an assistant superintendent of schools and a reading specialist from the New York City Public Schools are visiting us to discuss possibilities for cooperation in the development of programmed materials in the field of reading.
5. We are depending heavily on the Center for Programmed Instruction for advice and assistance. We also have agreed to cooperate with them in carrying on further research into techniques of programming. Later this year, we expect to be using the programmed texts which they developed on Sets, Relations and Functions as a means of testing certain hypotheses about program construction in relation to learning ability. We also hope to use their pre-verbal programs on number concepts in one or more of our kindergartens as soon as machines are available to handle the programs.
6. As soon as training sessions for potential programmers are in operation at the Center, we intend to send one or more teams of teachers as the first step toward the development of additional programs. Our next programming venture will be either in the field of spelling or remedial reading.

7. We do not intend to buy either teaching machines or commercially produced programs in their present stage of development. Rather, we intend to inform the producers that we are "available" and are willing to try out their products during the necessary experimental stages. We will, however, try programs only if we are convinced that they are based on appropriate subject content and an adequate understanding of programming techniques. We will try machines only if we are convinced that they are more than mechanical "page-turners."

And now in conclusion, I should like to return for a moment to the educational setting which I attempted to portray in my opening statements. It is a setting, I believe, in which new developments move very fast. The fifty year cultural lag is no longer operative. It seems to be increasingly evident, therefore, that the major responsibility for the future of programmed learning rests primarily with public school educators like myself. We cannot afford to wait for the academic scholars, the professors of education or our professional associations to tell us what to do. We must take the initiative, for if we don't it will be seized by others less qualified than we are to decide what should happen in the schools.

So it seems to me the choice is squarely up to us. We can hide our heads in the sand — we can climb on the bandwagon — or we can proceed with cautious enthusiasm to explore the potential of this promising new development in learning.